

SEQUENCE LISTING

<110> DeAngelis, Paul

<120> HEPARIN/HEPAROSAN SYNTHASE FROM P. MULTOCIDA, SOLUBLE AND SINGLE ACTION
CATALYSTS THEREOF AND METHODS OF MAKING AND USING SAME

<130> 4599.014

<150> 60/458,939

<151> 2003-03-31

<150> 10/142,143

<151> 2002-05-08

<150> 60/289,554

<151> 2001-05-08

<150> 60/296,386

<151> 2001-06-06

<150> 60/303,691

<151> 2001-07-06

<150> 60/313,258

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<160> 34

<170> PatentIn version 3.1

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<213> Pasteurella multocida

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Glu Leu Gly Ile Thr Lys Glu Arg Leu Gly Ala Pro Pro Leu Val Ser
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His Lys Lys Val Phe Gln Glu Ile Gly Phe Phe Asn Cys Thr Thr Lys
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Phe Tyr Lys Pro Leu Glu Lys Asp Lys Ala Val Asn Val Leu Gly Thr
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 Page 13

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90

95

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55

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Lys Phe Ser Lys Phe His Asp Tyr Thr Lys Asn Gly Tyr Lys Tyr Leu
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Ala Phe Asp Asn Gln Ala Asp Ala Gly Tyr Gly Leu Thr Leu Leu Leu
180 185 190

Asn Ala Asn Asp Asp Met Gln Asp Ser Tyr Asn Leu Leu Pro Glu Gln
195 200 205

Glu Leu Phe Ile Cys Asn Ala Val Ile Asp Asn Met Asn Ile Tyr Arg
210 215 220

Ser Gln Phe Asn Lys Cys Leu Arg Lys Tyr Asp Leu Ser Glu Ile Thr
225 230 235 240

Asp Ile Tyr Pro Asn Lys Ile Ile Leu Gln Gly Ile Lys Phe Asp Lys
245 250 255

Lys Lys Asn Val Tyr Gly Lys Asp Leu Val Ser Ile Ile Met Ser Val
260 265 270

Phe Asn Ser Glu Asp Thr Ile Ala Tyr Ser Leu His Ser Leu Leu Asn
275 280 285

Gln Thr Tyr Glu Asn Ile Glu Ile Leu Val Cys Asp Asp Cys Ser Ser
290 295 300

Asp Lys Ser Leu Glu Ile Ile Lys Ser Ile Ala Tyr Ser Ser Ser Arg
Page 15

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Val Glu His Phe Leu Lys Glu Ile Gly Met Asn Ser Pro Asn Tyr Ser
20 25 30

Thr Ser Asn Lys Ile Ser Pro Glu Tyr Ile Thr Ala Ser Leu Cys Gln
35 40 45

Phe Tyr Gln Thr Pro Glu Val Asn Asp Val Val Asp Glu Arg Glu Phe
50 55 60

Ser Ala Val Gln Val Ser Thr Met Trp Asp Ser Met Val Leu Glu Leu
65 70 75 80

Met Met Asn Asn Leu Asn Asn Lys Leu Trp Gly Trp Ala Asp Pro Ser
85 90 95

Ile Ile Phe Phe Leu Asp Phe Trp Lys Asn Ile Asp Lys Ser Ile Lys
100 105 110

Phe Ile Met Ile Tyr Asp His Pro Lys Tyr Asn Leu Met Arg Ser Val
115 120 125

Asn Asn Ala Pro Leu Ser Leu Asn Ile Asn Asn Ser Val Asp Asn Trp
130 135 140

Ile Ala Tyr Asn Lys Arg Leu Leu Asp Phe Phe Leu Glu Asn Lys Glu
145 150 155 160

Arg Cys Val Leu Ile Asn Phe Glu Ala Phe Gln Ser Asn Lys Lys Asn
165 170 175

Ile Ile Lys Pro Leu Ser Asn Ile Ile Lys Ile Asp Asn Leu Met Ser
180 185 190

Ala His Tyr Lys Asn Ser Ile Leu Phe Asp Val Val Glu Asn Asn Asp
195 200 205

Tyr Thr Lys Ser Asn Glu Ile Ala Leu Leu Glu Lys Tyr Thr Thr Leu
210 215 220

Phe Ser Leu Ser Ala Asn Glu Thr Glu Ile Thr Phe Asn Asp Thr Lys
225 230 235 240

Val Ser Glu Tyr Leu Val Ser Glu Leu Ile Lys Glu Arg Thr Glu Val
Page 17

245

250

255

Leu Lys Leu Tyr Asn Glu Leu Gln Ala Tyr Ala Asn Leu Pro Tyr Ile
 260 265 270

Glu Thr Ser Lys Asp Asn Val Ser Ala Glu Ala Ala Leu Trp Glu Val
 275 280 285

Val Glu Glu Arg Asn Ser Ile Phe Asn Ile Val Ser His Leu Val Gln
 290 295 300

Glu Ser Lys Lys Lys Asp Ala Asp Ile Glu Leu Thr Lys Ser Ile Phe
 305 310 315 320

Lys Lys Arg Gln Phe Leu Leu Leu Asn Arg Ile Asn Glu Leu Lys Lys
 325 330 335

Glu Lys Glu Glu Val Ile Lys Leu Ser Lys Ile Asn His Asn Asp Val
 340 345 350

Val Arg Gln Glu Lys Tyr Pro Asp Asp Ile Glu Lys Lys Ile Asn Asp
 355 360 365

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 370 375 380

Gln Ala Ile Ser Glu Lys Glu Gln Ile Leu Lys Gln Leu His Lys Tyr
 385 390 395 400

Glu Glu Glu Ile Ser Glu Lys Glu Ser Lys Leu Thr Gln Ala Ile Ser
 405 410 415

Glu Lys Glu Gln Ile Leu Lys Gln Leu His Ile Val Gln Glu Gln Leu
 420 425 430

Glu His Tyr Phe Ile Glu Asn Gln Glu Ile Lys Lys Lys Leu Pro Pro
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Val Leu Tyr Gly Ala Ala Glu Gln Ile Lys Gln Glu Leu Gly Tyr Arg
 450 455 460

Leu Gly Tyr Ile Ile Val Ser Tyr Ser Lys Ser Leu Lys Gly Ile Ile
 465 470 475 480

Thr Met Pro Phe Ala Leu Ile Arg Glu Cys Val Phe Glu Lys Lys Arg
 485 490 495

Lys Lys Ser Tyr Gly Val Asp Val Pro Leu Tyr Leu Tyr Ala Asp Ala
 Page 18

500

505

510

Asp Lys Ala Glu Arg Val Lys Lys His Leu Ser Tyr Gln Leu Gly Gln
 515 520 525

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<213> Pasteurella multocida

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 35 40 45

Ile Ala Ser Arg Ile Ala Asn Ser Thr Ser Lys Val Lys Thr Phe Arg
 50 55 60

Leu Asn Ser Asn Leu Gly Thr Tyr Phe Ala Lys Asn Thr Gly Ile Leu
 65 70 75 80

Lys Ser Lys Gly Asp Ile Ile Phe Phe Gln Asp Ser Asp Asp Val Cys
 85 90 95

His His Glu Arg Ile Glu Arg Cys Val Asn Ala Leu Leu Ser Asn Lys
 100 105 110

Asp Asn Ile Ala Val Arg Cys Ala Tyr Ser Arg Ile Asn Leu Glu Thr
 115 120 125

Gln Asn Ile Ile Lys Val Asn Asp Asn Lys Tyr Lys Leu Gly Leu Ile
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Thr Leu Gly Val Tyr Arg
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<213> Pasteurella multocida

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35 40 45

Asp Arg Ile Val Tyr Asn Phe Gln Lys Thr Phe Arg Lys Asp Thr Ala
50 55 60

Val Asn Ile Leu Gly Thr Gly Thr Val Ala Phe Arg Val Ser Ile Phe
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 Pro Leu Val Ser Ile Ile Met Thr Ser His Asn Thr Glu Lys Phe Ile
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 Glu Ala Ser Ile Asn Ser Leu Leu Leu Gln Thr Tyr Asn Asn Leu Glu
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 Val Ile Val Val Asp Asp Tyr Ser Thr Asp Lys Thr Phe Gln Ile Ala
 85 90 95
 Ser Arg Ile Ala Asn Ser Thr Ser Lys Val Lys Thr Phe Arg Leu Asn
 100 105 110
 Ser Asn Leu Gly Thr Tyr Phe Ala Lys Asn Thr Gly Ile Leu Lys Ser
 115 120 125
 Lys Gly Asp Ile Ile Phe Phe Gln Asp Ser Asp Asp Val Cys His His
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 Glu Arg Ile Glu Arg Cys Val Asn Ala Leu Leu Ser Asn Lys Asp Asn
 145 150 155 160
 Ile Ala Val Arg Cys Ala Tyr Ser Arg Ile Asn Leu Glu Thr Gln Asn
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 Ile Ile Lys Val Asn Asp Asn Lys Tyr Lys Leu Gly Leu Ile Thr Leu
 180 185 190
 Gly Val Tyr Arg Lys Val Phe Asn Glu Ile Gly Phe Phe Asn Cys Thr
 195 200 205
 Thr Lys Ala Ser Asp Asp Glu Phe Tyr His Arg Ile Ile Lys Tyr Tyr
 210 215 220
 Gly Lys Asn Arg Ile Asn Asn Leu Phe Leu Pro Leu Tyr Tyr Asn Thr
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 Met Arg Glu Asp Ser Leu Phe Ser Asp Met Val Glu Trp Val Asp Glu
 245 250 255

Asn Asn Ile Lys Gln Lys Thr Ser Asp Ala Arg Gln Asn Tyr Leu His
260 265 270

Glu Phe Gln Lys Ile His Asn Glu Arg Lys Leu Asn Glu Leu Lys Glu
275 280 285

Ile Phe Ser Phe Pro Arg Ile His Asp Ala Leu Pro Ile Ser Lys Glu
290 295 300

Met Ser Lys Leu Ser Asn Pro Lys Ile Pro Val Tyr Ile Asn Ile Cys
305 310 315 320

Ser Ile Pro Ser Arg Ile Lys Gln Leu Gln Tyr Thr Ile Gly Val Leu
325 330 335

Lys Asn Gln Cys Asp His Phe His Ile Tyr Leu Asp Gly Tyr Pro Glu
340 345 350

Val Pro Asp Phe Ile Lys Lys Leu Gly Asn Lys Ala Thr Val Ile Asn
355 360 365

Cys Gln Asn Lys Asn Glu Ser Ile Arg Asp Asn Gly Lys Phe Ile Leu
370 375 380

Leu Glu Lys Leu Ile Lys Glu Asn Lys Asp Gly Tyr Tyr Ile Thr Cys
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Asp Asp Asp Ile Arg Tyr Pro Ala Asp Tyr Ile Asn Thr Met Ile Lys
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Lys Ile Asn Lys Tyr Asn Asp Lys Ala Ala Ile Gly Leu His Gly Val
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Ile Phe Pro Ser Arg Val Asn Lys Tyr Phe Ser Ser Asp Arg Ile Val
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Tyr Asn Phe Gln Lys Pro Leu Glu Asn Asp Thr Ala Val Asn Ile Leu
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Gly Thr Gly Thr Val Ala Phe Arg Val Ser Ile Phe Asn Lys Phe Ser
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485 490 495

Leu Cys Lys Lys Asn Asn Ile Leu Gln Val Cys Ile Ser Arg Pro Ser
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Asn Trp Leu Thr Glu Asp Asn Lys Asn Thr Glu Thr Leu Phe His Glu
 515 520 525

Phe Gln Asn Arg Asp Glu Ile Gln Ser Lys Leu Ile Ile Ser Asn Asn
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 35 40 45

Val Ile Val Val Asp Asp Tyr Ser Thr Asp Lys Thr Phe Gln Ile Ala
 50 55 60

Ser Arg Ile Ala Asn Ser Thr Ser Lys Val Lys Thr Phe Arg Leu Asn
 65 70 75 80

Ser Asn Leu Gly Thr Tyr Phe Ala Lys Asn Thr Gly Ile Leu Lys Ser
 85 90 95

Lys Gly Asp Ile Ile Phe Phe Gln Asp Ser Asp Asp Val Cys His His
 100 105 110

Glu Arg Ile Glu Arg Cys Val Asn Ala Leu Leu Ser Asn Lys Asp Asn
 115 120 125

Ile Ala Val Arg Cys Ala Tyr Ser Arg Ile Asn Leu Glu Thr Gln Asn
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Ile Ile Lys Val Asn Asp Asn Lys Tyr Lys Leu Gly Leu Ile Thr Leu
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Gly Val Tyr Arg Lys Val Phe Asn Glu Ile Gly Phe Phe Asn Cys Thr
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Thr Lys Ala Ser Asp Asp Glu Phe Tyr His Arg Ile Ile Lys Tyr Tyr
180 185 190

Gly Lys Asn Arg Ile Asn Asn Leu Phe Leu Pro Leu Tyr Tyr Asn Thr
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Met Arg Glu Asp Ser Leu Phe Ser Asp Met Val Glu Trp Val Asp Glu
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Asn Asn Ile Lys Gln Lys Thr Ser Asp Ala Arg Gln Asn Tyr Leu His
225 230 235 240

Glu Phe Gln Lys Ile His Asn Glu Arg Lys Leu Asn Glu Leu Lys Glu
245 250 255

Ile Phe Ser Phe Pro Arg Ile His Asp Ala Leu Pro Ile Ser Lys Glu
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Met Ser Lys Leu Ser Asn Pro Lys Ile Pro Val Tyr Ile Asn Ile Cys
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Ser Ile Pro Ser Arg Ile Lys Gln Leu Gln Tyr Thr Ile Gly Val Leu
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Lys Asn Gln Cys Asp His Phe His Ile Tyr Leu Asp Gly Tyr Pro Glu
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Val Pro Asp Phe Ile Lys Lys Leu Gly Asn Lys Ala Thr Val Ile Asn
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Cys Gln Asn Lys Asn Glu Ser Ile Arg Asp Asn Gly Lys Phe Ile Leu
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Ile Phe Pro Ser Arg Val Asn Lys Tyr Phe Ser Ser Asp Arg Ile Val
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Tyr Asn Phe Gln Lys Pro Leu Glu Asn Asp Thr Ala Val Asn Ile Leu
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Gly Thr Gly Thr Val Ala Phe Arg Val Ser Ile Phe Asn Lys Phe Ser
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Leu Ser Asp Phe Glu His Pro Gly Met Val Asp Ile Tyr Phe Ser Ile
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Leu Cys Lys Lys Asn Asn Ile Leu Gln Val Cys Ile Ser Arg Pro Ser
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Asn Trp Leu Thr Glu Asp Asn Lys Asn Thr Glu Thr Leu Phe His Glu
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Phe Gln Asn Arg Asp Glu Ile Gln Ser Lys Leu Ile Ile Ser Asn Asn
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20 25 30

Xaa Xaa Val Xaa Xaa Xaa Xaa Xaa Xaa Xaa Asn Xaa Gly Xaa Tyr Xaa
Page 32

35

40

45

Xaa Xaa Xaa Xaa Xaa Xaa Xaa Xaa Xaa Xaa Xaa Xaa Xaa Xaa Xaa Phe
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	20	25	30
Met Xaa Xaa	Xaa Xaa Xaa Xaa	Xaa Xaa Xaa Xaa	Xaa Xaa Xaa
	35	40	45
Xaa Xaa Xaa	Xaa Xaa Xaa Xaa	Xaa Xaa Xaa Xaa	Xaa Xaa Xaa
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Thr Val

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<211> 617

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<213> Pasteurella multocida

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Lys Phe Ser Val Ser Ile Lys Asp Leu Tyr Asn Glu Ile Ser Asn Ser
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Glu Leu Gly Ile Thr Lys Glu Arg Leu Gly Ala Pro Pro Leu Val Ser
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Ile Ile Met Thr Ser His Asn Thr Glu Lys Phe Ile Glu Ala Ser Ile
100 105 110

Asn Ser Leu Leu Leu Gln Thr Tyr Asn Asn Leu Glu Val Ile Val Val
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Asp Asp Tyr Ser Thr Asp Lys Thr Phe Gln Ile Ala Ser Arg Ile Ala
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145 150 155 160

Thr Tyr Phe Ala Lys Asn Thr Gly Ile Leu Lys Ser Lys Gly Asp Ile
165 170 175

Ile Phe Phe Gln Asn Ser Asn Asp Val Cys His His Glu Arg Ile Glu
180 185 190

Arg Cys Val Asn Ala Leu Leu Ser Asn Lys Asp Asn Ile Ala Val Arg
195 200 205

Cys Ala Tyr Ser Arg Ile Asn Leu Glu Thr Gln Asn Ile Ile Lys Val
210 215 220

Asn Asp Asn Lys Tyr Lys Leu Gly Leu Ile Thr Leu Gly Val Tyr Arg
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Lys Val Phe Asn Glu Ile Gly Phe Phe Asn Cys Thr Thr Lys Ala Ser
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290 295 300

Gln Lys Thr Ser Asp Ala Arg Gln Asn Tyr Leu His Glu Phe Gln Lys
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370 375 380

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Glu His Pro Gly Met Val Asp Ile Tyr Phe Ser Ile Leu Cys Lys Lys
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<210> 26

<211> 1854

<212> DNA

<213> Pasteurella multocida

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<210> 27

<211> 617

<212> PRT

<213> Pasteurella multocida

<400> 27

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Gln Ser Lys Ser Asn Lys Ile Glu Glu Asp Asn Ile Ser Gly Glu Asn
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Lys Phe Ser Val Ser Ile Lys Asp Leu Tyr Asn Glu Ile Ser Asn Ser
 65 70 75 80

Glu Leu Gly Ile Thr Lys Glu Arg Leu Gly Ala Pro Pro Leu Val Ser
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Ile Ile Met Thr Ser His Asn Thr Glu Lys Phe Ile Glu Ala Ser Ile
 100 105 110

Asn Ser Leu Leu Leu Gln Thr Tyr Asn Asn Leu Glu Val Ile Val Val
 115 120 125

Asp Asp Tyr Ser Thr Asp Lys Thr Phe Gln Ile Ala Ser Arg Ile Ala
 Page 40

130

135

140

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Thr Tyr Phe Ala Lys Asn Thr Gly Ile Leu Lys Ser Lys Gly Asp Ile
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195 200 205

Cys Ala Tyr Ser Arg Ile Asn Leu Glu Thr Gln Asn Ile Ile Lys Val
210 215 220

Asn Asp Asn Lys Tyr Lys Leu Gly Leu Ile Thr Leu Gly Val Tyr Arg
225 230 235 240

Lys Val Phe Asn Glu Ile Gly Phe Phe Asn Cys Thr Thr Lys Ala Ser
245 250 255

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260 265 270

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275 280 285

Ser Leu Phe Ser Asp Met Val Glu Trp Val Asp Glu Asn Asn Ile Lys
290 295 300

Gln Lys Thr Ser Asp Ala Arg Gln Asn Tyr Leu His Glu Phe Gln Lys
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Ile His Asn Glu Arg Lys Leu Asn Glu Leu Lys Glu Ile Phe Ser Phe
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Pro Arg Ile His Asp Ala Leu Pro Ile Ser Lys Glu Met Ser Lys Leu
340 345 350

Ser Asn Pro Lys Ile Pro Val Tyr Ile Asn Ile Cys Ser Ile Pro Ser
355 360 365

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<211> 1956

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<213> Pasteurella multocida

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<211> 651

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<213> Pasteurella multocida

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 Val Arg Cys Ala Tyr Ser Arg Leu Ala Pro Glu Thr Gln His Ile Ile
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 Gly Ser Asp Asp Glu Phe Phe His Arg Ile Ala Lys Tyr Tyr Gly Lys
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Ile Ile Gln Lys Met Ser Asp Thr Arg Gln His Tyr Ala Thr Leu Phe
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Gln Ala Met His Asn Glu Thr Ala Ser His Asp Phe Lys Asn Leu Phe
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Lys Leu Ser Asn Pro Lys Ile Pro Val Tyr Ile Asn Ile Cys Ser Ile
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Pro Ser Arg Ile Ala Gln Leu Arg Arg Ile Ile Gly Ile Leu Lys Asn
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Gln Cys Asp His Phe His Ile Tyr Leu Asp Gly Tyr Val Glu Ile Pro
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Gly Tyr Ser Ser Ile Tyr Pro Leu Val Lys Asn His Pro Lys Phe Thr
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